

**CITY OF LINCOLN, NEBRASKA, STANDARD SPECIFICATIONS**

**CHAPTER 21**

**STORM DRAINAGE SYSTEMS**

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**CHAPTER 21**

**STORM DRAINAGE SYSTEMS**

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**CHAPTER 21**

**STORM DRAINAGE SYSTEMS**

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## CHAPTER 21

### STORM DRAINAGE SYSTEMS

#### 21.00 GENERAL

The Work covered in this chapter shall include the laying and jointing of storm drain pipe, concrete box construction, concrete channel liners, and construction of storm drain appurtenances.

#### 21.01 MATERIALS

##### A. CONCRETE

Concrete used in storm drain construction and reconstruction shall conform to the requirements of Chapter 3 of these Standard Specifications.

##### B. REINFORCED CONCRETE PIPE

1. Reinforced concrete pipe shall be circular in cross section, unless otherwise indicated, with tongue and groove joints, and shall be manufactured in conformance with the requirements of “Standard Specifications for Reinforced Concrete Culvert Pipe, Storm Drain and Sewer Pipe”, ASTM Designation C 76 for Class III Pipe with Wall B, unless otherwise specified on the plans or in the Special Provisions.
2. When so indicated on the plans, reinforced concrete elliptical pipe shall be supplied and shall be manufactured in conformance with the requirements of “Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe”, ASTM Designation C 507.

##### C. RUBBER GASKET

Rubber gaskets shall be from extruded closed cell rubber.

1. The base polymer shall be a blend of neoprene and EPDM meeting the physical requirements of “Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber”, ASTM D 1056, Class 2C2.
2. The closed cell rubber shall meet the ozone testing requirement of “Standard Test Method for Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)”, ASTM D 1171, of 70 hours at a 40° C at 100 PHM, bent loop with no cracks.
3. Each seal shall be completely covered with a natural skin and shall be assembled into a continuous ring which shall conform to the joint size and shape.
4. Cross sectional dimensions shall conform to RMA Class II tolerances and installation shall be in conformance with the manufacturer’s recommendations.

## 21.01 MATERIALS (Continued)

### D. IRON CASTINGS

All iron castings shall meet the requirements of “Standard Specification for Gray Iron Castings”, ASTM Designation A 48, Class 30. They shall conform in all respects to the designs for such castings as shown on the Standard Plans. All frames and covers shall be machined so that each cover will fit properly in its frame with no rocking. No casting will be accepted that is warped, cracked, has swells, or that has been plugged or filled.

### E. CONCRETE REINFORCEMENT

1. **REINFORCEMENT BARS:** All reinforcement bars shall meet the requirements of “Standard Specifications for Deformed and Plain Billet Steel Bars for Concrete Reinforcement”, ASTM Designation A 615, Grade 40 or Grade 60. Bars shall be free from excess rust, scale, or other substances which prevent the bonding of the concrete to the reinforcement.
2. **REINFORCEMENT BAR SUPPORTS:** Reinforcement bar supports shall be of a satisfactory design and of sufficient strength to hold the metal reinforcement in place while the concrete is being placed.

### F. BRICK

All brick shall be clean, hard burned brick having true shape and sharp edges for their whole length. Unless otherwise specified, all brick shall be new brick. Broken brick shall be used only to close joints and no bats smaller than half a brick shall be used. In addition to the foregoing, all brick shall meet all the requirements of “Standard Specification for Sewer and Manhole Brick Made From Clay or Shale”, ASTM Designation C 32; all drain brick shall be Grade SS and all manhole brick shall be Grade MS. Concrete brick conforming to “Standard Specification for Concrete Brick”, ASTM Designation C 55, Grade N 1, may be used in lieu of the clay or shale brick specified above.

### G. MORTAR

Mortar used in the construction of manholes or other appurtenant structures shall be Type S as specified in “Standard Specification for Mortar for Unit Masonry”, ASTM Designation C 270. Proportions of the mixture shall conform to either of the two following alternatives:

| <u>Alternate</u> | <u>Portland<br/>Cement</u> | <u>Masonry<br/>Cement</u> | <u>Hydrated Lime<br/>or Lime Putty</u> | <u>Aggregate<br/>Loose &amp; Damp</u>   |
|------------------|----------------------------|---------------------------|--|---|
| 1                | 1/2                        | 1                         | 0                                      | Not less than 2 1/4 nor more than<br>than 3 times the sum of the volume<br>of the cements and lime used |
| 2                | 1                          | 0                         | 1/4-1/2                                |   |

### H. PRECAST MANHOLE SECTIONS

Precast manhole sections shall be manufactured in conformance with the requirements of “Standard Specification for Precast Reinforced Concrete Manhole Sections”, ASTM Designation C 478.

## 21.01 MATERIALS (Continued)

### I. PRECAST BOX CULVERTS

When so indicated on the plans, precast box culverts shall be supplied and shall be manufactured in conformance with the requirements of "Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains and Sewers", ASTM Designation C 1433.

### J. WIRE GABION

GABION shall be supplied as specified, in various lengths and heights. The lengths shall be multiples of the horizontal width. The heights shall be fractions of the horizontal width. The horizontal width shall not be less than 3'. However, all gabion furnished by a manufacturer shall be of uniform width. Dimensions for heights, lengths and widths are subject to a tolerance limit of  $\pm 5\%$  of manufacturer's stated sizes.

GABION shall be fabricated in such a manner that the sides, ends, lid, and diaphragms can be assembled at the construction site into a rectangular basket of the specified sizes. GABION shall be of single unit construction. The base, lid, ends, and sides shall be either woven into a single unit or one edge of these members connected to the base section of the gabion in such a manner that strength and flexibility at the point of connection is at least equal to that of the mesh.

Where the length of the gabion exceeds its horizontal width, the gabion shall be equally divided by diaphragms of the same mesh and gauge as the body of the gabion into cells whose length does not exceed the horizontal width. The gabion shall be furnished with the necessary diaphragms secured in proper position on the base in such a manner that no additional tying at this juncture will be necessary.

GABION shall be made of hexagonal triple twist mesh  $3\frac{1}{4}'' \times 4\frac{1}{2}''$ . The wire mesh shall be made of galvanized steel wire having a diameter of  $0.1181'' \pm 2.5\%$ . The tensile strength of the wire shall be in the range of 60,000 to 85,000 p.s.i. The minimum zinc coating of the wire shall be 0.80 ounces per square foot of uncoated wire surface in conformance with Federal Specification QQ-W-461g, Class 3.

All perimeter edges of the mesh forming the gabion shall be securely salvaged so that the joints formed by tying the selvages have at least the same strength as the body of the mesh.

Tie wire or connecting wire shall be supplied in sufficient quantity for securely fastening all edges of the gabion and diaphragms. The tie wire shall meet the same Standard Specifications as the wire used in the mesh, except that it shall have a diameter of  $0.0866'' + 2.5\%$ . Tie wire and connecting wire used for assembling or connecting to PVC coated gabion shall be PVC coated wire provided by the gabion manufacturer for that purpose.

The wire mesh for PVC coated baskets shall be made of galvanized steel wire and shall conform to all Standard Specifications for galvanized baskets except that the mesh wire exclusive of PVC coating may be  $0.0118''$  smaller in diameter.

The PVC coating shall be a minimum of four-tenths millimeter in thickness. The PVC coating shall be applied prior to weaving of the baskets.

The PVC protective coating shall be resistant to the air and sea water and shall comply with the following test requirements:

## 21.01 MATERIALS (Continued)

### J. WIRE GABION (Continued)

1. Immersion of the wire for 20 hours in Hydrochloric acid (solution composed 50% H<sub>2</sub>O and 50% HCL concentration 21 Baume-Test temperature 15° C or immersion for 60 hours in a saturated solution of salt water at 15° C without noticeable loss of weight due to corrosion of the coating material and without reduction of the wire's diameter.
2. After immersion of a length of the coated wire in a 3.5% solution of Potassium Permanganate (KMnO<sub>4</sub>) for a continuous period of 50 at an ambient temperature, the maximum penetration between the coating and the core wire from a square cut end shall be 0.472".
3. The protective coating shall not be altered or deformed by temperatures ranging between 150.0°F and -40°F.

### K. GABION STONE

The stone used to fill the gabion shall be from sources approved by the City's Project Manager. The size of the stone shall be such that not more than 5% by mass shall pass the 4" sieve. The maximum weight for any one stone shall not exceed 50 pounds. The maximum length of stone shall not exceed 12". Each stone shall have one dimension that has a measurement of 4". The approved stone shall conform to the soundness requirements of "Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate", ASTM Designation C 88.

### L. GROUT FILLED FABRIC

Grout shall consist of a mixture of Portland cement, fine aggregate, and water so proportioned and mixed as to provide a pumpable slurry. Pozzolan and grout fluidifier conforming to these Standard Specifications may be used at the option of the Contractor. The mix shall exhibit a compressive strength of 2000 p.s.i. at 28 days when made and tested in conformance with "Standard Practice for Making and Curing Concrete Test Specimens in the Field", ASTM C 31 and "Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens", ASTM Designation C 39, or "Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in Laboratory", ASTM Designation C 942 if a grout fluidifier is used.

Grout components shall conform to the following:

1. Portland cement: Federal Specifications SS-C 192 or "Specification for Portland Cement", ASTM Designation C 150.
2. Pozzolan, if used: "Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete", ASTM Designation C 618/C 618 M.
3. Water shall be fresh, clean, and free from injurious amounts of sewage, oil, acid, alkali, salts, or organic matter.
4. Aggregate: "Standard Specification for Concrete Aggregates", ASTM Designation C 33, except as to grading. Aggregate grading shall be reasonably consistent and shall be well graded from the maximum size which can be conveniently handled with available pumping equipment.

## 21.01 MATERIALS (Continued)

### L. GROUT FILLED FABRIC (Continued)

5. Grout fluidifier, if used: “Standard Specification for Grout Fluidifier for PrePlaced-Aggregate Concrete”, ASTM C 937.

The average compressive strength of the grout-filled fabric test cylinders shall be at least 20% higher at seven days than that of companion test cylinders made in conformance with “Standard Practice for Making and Curing Concrete Test Specimens in the Field”, ASTM Designation C 31, or “Standard Test Method for Compressive Strength of Grouts for Preplaced Aggregate Concrete in the Laboratory”, ASTM Designation C 942 if grout fluidifier is used, and not less than 2500 p.s.i. at 28 days.

Fabric forming material shall be “Fabriform” or approved equal.

Fabric forming material shall consist of specially-woven multiple panels of double-layer, open-selvage fabric joined in a mat configuration. The two fabric layers shall each be no lighter than 18 x 18 count per inch, 1000 denier nylon or 1000 denier polyester tire cord, of which at least 50% by weight shall be producer-bulked continuous multi filament tire cord nylon. Fabric of equal or greater strength and porosity may be used with the approval of the City’s Project Manager. Fabric containing film type polypropylene fiber shall not be considered as an acceptable alternate by reason of its low strength, low bond to mortar and extreme sensitivity to ultraviolet degradation.

1. Filter Point fabric (designated as FP on drawings) shall consist of multiple panels of double layer fabric joined together in such a manner as to provide Filter Points on spaced centers for the relief of hydrostatic uplift pressure. Filter Points shall be woven in such a manner as to permit passage of ground water through the Filter Points. Filter Points shall be on approximately 5" or 8" or 10" centers as woven and as indicated on drawings.
2. Uniform Cross Section Fabric (designated as UCS on drawings) shall consist of multiple panels of double layer fabric joined together by interwoven ties of a uniform length spaced no further apart than 3" centers. Hydrostatic uplift relief, where required, shall be provided by sewing together the two fabric layers at locations and in the manner indicated on the drawings or by inserting plastic tubes through the mat on specified centers. Filter cloth shall be placed beneath the mat if plastic or other type tubes are used to prevent passage of fines through the tubes. These tubes shall be installed in such a manner as to ensure that no damage to filter cloth occurs.
3. Individual mill width panels shall be cut to suitable length and the two layers of fabric separately joined edge to edge by means of nylon thread. The tensile strength of stitched joints shall be not less than 100 pounds per inch.
4. Fabric porosity is essential for the successful execution of this Work. At the direction of the City’s Project Manager, the Contractor shall demonstrate the suitability of fabric design by injecting the proposed grout into 6" diameter sleeves under a pressure of 10 to 15 p.s.i. which shall be maintained by means of air pressure or a standpipe for 10 minutes. The sleeves shall be constructed of the same fabric used in the individual layers of fabric. 6" x 12" test cylinders shall be cut from each specimen and tested in conformance with “Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens”, ASTM Designation C 39.



**21.01 MATERIALS (Continued)**

**M. GEOTEXTILE FILTER FABRIC**

Geotextile filter fabric shall be of nonwoven needle punched construction and consist of continuous long chain polymeric fibers composed of polyester polypropylene, polyethylene, or polyamide. The fibers shall be oriented into a multi-directional stable network which retains their positions relative to each other and allows the passage of water as specified. The fabric shall be free of any chemical treatment or coating which reduces permeability. The fabric shall be puncture and tear resistant; mildew, rodent, insect, and rot resistant; freeze and thaw stable; and shall be inert to chemicals commonly found in acid or alkaline soils. The fabric shall be resistant to deterioration due to ultraviolet light and/or heat exposure. The geotextile shall conform to typical physical properties, as shown below:

| <u>Physical Property</u>                       | <u>Test Procedure</u>   | <u>Minimum Test Results</u> |
|--|---|-----------------------------|
| Tensile Strength, wet, lbs.                    | ASTM D 1682   | 175 (80)                    |
| Elongation, wet, %                             | ASTM D 1682   | 65                          |
| Coefficient of Water Permeability, cm/sec.     | Constant head   | 0.10                        |
| Puncture Strength, lbs.                        | ASTM D 751*   | 90                          |
| Mullen Burst Strength, psi                     | ASTM D 3786   | 335                         |
| Abrasion Resistance, lbs.                      | ASTM D 3884<br>Taber Test<br>(1000 revolutions, 1 kg. load/wheel) | 55 (min.)                   |
| Pore Size – EOS                                | Corps of Engineers<br>CW-02215                                    | 70-100                      |
| Ultraviolet Resistance<br>% Strength Retention | ASTM D-1682<br>(After 500 Xenon Weatherometer Hours)              | 70                          |

\*Tension testing machine with ring clamp; steel ball replaced with a 5/16" diameter solid steel cylinder with hemispherical tip centered within the ring clamp.

The fabric shall have a minimum weight of 5 ounces per square yard.

The geotextile shall be furnished in a protective wrapping which shall protect the fabric from ultraviolet radiation and from abrasion due to shipping and handling.

**21.02 EXCAVATION AND BACKFILL**

Excavation and backfill shall conform to the requirements of Chapter 20 of these Standard Specifications.

## 21.03 LAYING PIPE

### A. GENERAL

For all ordinary laying conditions in firm soils, the Contractor shall lay each pipe to line and grade, taking care to provide depressions for jointing of each pipe.

All pipe shall be laid to line and grade as indicated on the plans. The laying of pipe shall begin at the lowest point in the line and proceed upgrade. Spigot ends shall be laid in the direction of flow. All pipe shall be so laid, fitted, and matched as to form a drain with a smooth, uniform, and continuous interior surface throughout.

After each pipe has been laid and firmly bedded in place, the entire joint space and lift hole shall be completely filled with mortar composed of 1-part Portland Cement and 2 parts of clean sand by volume. If the pipes are of 36" in diameter or larger, the joint space shall also be filled on the inside surface of the pipe. The mortar shall be cured and protected as directed by the City's Project Manager.

In lieu of the mortar joint specified above, joints may be made of approved rubber gaskets or cold mix asphalt jointing compound. The methods of making the joints and filling of lift holes shall be approved by the City's Project Manager.

The open end of the pipes shall be protected at all times against the entrance of earth or other foreign material.

Tight bulkheads shall be placed in all open ends when pipe laying is stopped. The ditch or swale shall be graded as necessary to permit the proper entrance of surface runoff into or out of the system.

When called for on the plans, the Contractor shall remove and relay reinforced concrete storm drain pipes to the lines and grades indicated. The Contractor shall exercise care in the removal so as not to damage the existing pipe or the pipe removed. Where pipes are unavoidably damaged, the Contractor shall replace the damaged pipe with new material and be compensated as provided below. Where, in the opinion of the City's Project Manager, pipes are damaged due to neglect of the Contractor, the pipe shall be removed and replaced with new materials at the Contractor's cost.

When the plans or Contract Documents call for removal and salvage of storm drain pipes, the Contractor shall remove and reuse the salvaged pipes. Where pipes are to be removed and salvaged but are, in the opinion of the City's Project Manager, damaged beyond their usefulness, the Contractor shall be compensated for removal only and separately be compensated for new. When the plans or Contract Documents call for removal of storm drain pipes, the Contractor shall remove and dispose of the pipes off the job site.

## **21.03 LAYING PIPE (Continued)**

### **B. BASIS OF PAYMENT**

Reinforced concrete storm drain pipe removed, removed and re-laid, or removed and salvaged in conformance with these Standard Specifications and accepted by the City's Project Manager, shall be measured and paid for at the contract unit price bid per linear foot for REMOVE STORM DRAIN PIPE, \_\_\_"; REMOVE AND RELAY RCP STORM DRAIN, \_\_\_"; REMOVE AND SALVAGE RCP STORM DRAIN, \_\_\_". Such payment shall be full compensation for all excavation, removal, bedding if required, relaying, loading salvaged pipe, backfill disposal, materials, equipment, tools, labor, and incidentals necessary to perform the Work called for as per plan.

Reinforced Concrete Pipe (RCP) storm drain pipe, elliptical Reinforced Concrete Pipe (RCP), and precast reinforced concrete (RC) box storm drains, constructed in conformance with these Standard Specifications and accepted by the City's Project Manager, shall be measured from inside face of structure to inside face of structure, or to the end of the pipe or precast box for each size of pipe or precast box.

Payment for pipes and precast boxes shall be made at the contract unit price bid per linear foot for RCP STORM DRAIN, CLASS \_\_, \_\_\_"; ELLIPTICAL RCP STORM DRAIN, \_\_\_" x \_\_\_"; PRECAST RC BOX STORM DRAIN for the various sizes shown on the proposal. Such payment shall be full compensation for all excavation, bedding, jointing, backfill, materials, equipment, tools, labor, and incidentals necessary to complete the items of Work called for as per plan.

Grading required as a part of storm drainage construction shall not be measured or paid for separately. The costs of such grading shall be considered as subsidiary to the costs of the items for which direct payment is made.

## **21.04 CURVED REINFORCED CONCRETE STORM DRAIN PIPE**

Straight sections of reinforced concrete pipe may be installed on curves by opening the outside of the joints in conformance with this Standard Specification. Installation of reinforced concrete pipe on a curve will only be allowed with prior approval of the City's Project Manager or Engineer. Where reinforced concrete pipe is to be installed on radii smaller than those shown in this Standard Specification, radius or beveled pipe shall be used only with the prior approval of the City's Project Manager.

All joints that have the outside of the joint opened to form the curved alignment shall be filled with mortar or mastic. The maximum joint opening shall be not more than 1/2 of the tongue length.

No separate measurement or payment shall be made for beveled or radius pipe. The measurement and payment for beveled and radius pipe shall be included in the measurement and payment for standard storm drain pipes as provided in Chapter 21 of these Standard Specifications.

**21.04 CURVED REINFORCED CONCRETE STORM DRAIN PIPE (Continued)**

**TABLE 21.04 A - CURVED REINFORCED CONCRETE STORM DRAIN PIPE**

| Nominal Diameter inches | Tongue Length inches | Maximum Joint Opening inches | Minimum Radius in feet for Given Laying Length (LL)<br>(using unbeveled round pipe) |          |
|-------------------------|----------------------|------------------------------|---|----------|
|                         |                      |                              | 4 ft. LL  | 8 ft. LL |
| 15                      | 3 3/8                | 1 5/8                        | 50  | 101      |
| 18                      | 3 3/8                | 1 5/8                        | 55  | 110      |
| 21                      | 3 3/8                | 1 5/8                        | 63  | 127      |
| 24                      | 3 3/8                | 1 5/8                        | 72  | 144      |
| 30                      | 3 3/8                | 1 5/8                        | 89  | 177      |
| 36                      | 3 7/8                | 1 5/8                        | 105   | 211      |
| 42                      | 3 7/8                | 1 7/8                        | 106   | 212      |
| 48                      |                      | 1 7/8                        | 121   | 241      |
| 54                      | 4 7/8                | 2 3/8                        | 107   | 215      |
| 60                      | 4 7/8                | 2 3/8                        | 119   | 238      |
| 72                      |                      | 2 3/8                        | 142   | 284      |
| 84                      | 5                    | 2 1/2                        | 162   | 325      |

## **21.05 CONNECTIONS TO EXISTING STORM DRAINS**

### **A. GENERAL**

The Contractor shall make all connections and taps of the new storm drains to existing storm drainage systems as shown on the plans. Tapping pipe should not extend more than 2" into existing pipe. Existing manhole or inlet bottoms shall, if necessary, be reconstructed in substantially the same manner as herein specified.

### **B. BASIS OF PAYMENT**

Connections to existing storm drainage systems, constructed in conformance with these Standard Specifications and accepted by the City's Project Manager, shall be measured and paid for at the contract unit price bid per each for TAP EXISTING STORM DRAIN MANHOLE AND REPLACE INVERT; TAP EXISTING STORM DRAIN INLET AND REPLACE INVERT; TAP EXISTING RCP; or TAP EXISTING RC BOX, for each item called for in the proposal. No classification shall be made as to sizes of pipes being tapped or sizes of connecting pipes. Such payment shall be full compensation for all tapping, shaping the connecting pipes, brick, mortar, concrete, materials, equipment, tools, labor, and incidentals necessary to complete the taps and seal the resulting voids in the walls of the storm drains in conformance with the details shown on the drawings.

No direct measurement or payment shall be made for connections or taps of various parts of the Work to other parts of the Work performed under the same contract. The cost of these taps and connections shall be considered subsidiary to the other items for which direct payment is made.

## 21.06 REINFORCED CONCRETE BOX STORM DRAINS AND STRUCTURES

### A. GENERAL

Reinforced concrete box storm drains and structures shall be complete, including box section, wing walls, apron, manholes, taps, connections, etc. Steel reinforcement shall be placed as indicated on the plans.

### B. FORMS

Forms shall be true to the required shapes and sizes, properly braced, and strong and stiff enough to withstand, without springing or warping, all operations incidental to laying the mat of steel reinforcement and placing the concrete. They shall be mortar tight, and the form surfaces in contact with the concrete shall be smooth and clean. To prevent adhesion to the concrete, the contact surfaces of all forms shall be coated with soap, mineral oil, or other substances, and they shall be thoroughly wetted before the concrete is placed.

Tie wires and tie rods may be left in the concrete, providing the end portions are removed to within approximately 2" of any exposed face. All holes left after removal of the rod or wire ends shall be completely filled with cement mortar immediately after the concrete curing forms have been removed. Such mortar shall be kept moist until thoroughly bonded to the concrete. Before depositing any concrete in the forms, the City's Project Manager shall make an observation of the condition of the forms and the placing of the reinforcing steel. All imperfections in either shall be remedied before any concrete is placed.

During the process of placing the concrete in any formed section, a taut line shall be kept in place by the Contractor at the back side of the forms. Competent workers shall keep a constant check to determine any deflection of the forms. Any such deflection shall be corrected immediately.

The Contractor shall use great care in the removal of forms so as not to injure the concrete in any way, and he shall be wholly responsible for any injury due to premature removal of forms. Wall forms, normally, may be removed 12 to 24 hours after placement of the concrete. Roof forms shall remain in place until tests show that the concrete has developed a compressive strength of 3000 p.s.i. Test specimens and tests shall comply with current ASTM Standards. Test specimens shall be cured under job conditions. In the absence of such tests, roof forms shall remain in place 7 days when the average ambient temperature has been 55° F for 12 hours or more. Forms shall not be removed without permission of the City's Project Manager.

### C. STEEL REINFORCEMENTS

The exact position and bar size of the reinforcements are shown on the plans. Information for purchasing, cutting and bending the bars shall be furnished by the Contractor. The bars shall be secured in position by suitable means, so they will not be displaced during the process of depositing or consolidating the concrete.

Steel reinforcement shall be stored on the Work site in such a manner as to protect it from any damage or surface deterioration.

Cold bends shall be made around a pin having a diameter of not less than 6 times the nominal diameter of the bar.

All reinforcing steel shall be furnished in full length, except where splices are indicated in the plan or permitted by the City's Project Manager. Splices in adjacent bars shall be staggered.

## 21.06 REINFORCED CONCRETE BOX STORM DRAINS AND STRUCTURES (Continued)

### C. STEEL REINFORCEMENTS (Continued)

Unless otherwise shown in the plans, bars shall be spliced by lapping the ends. Laps shall be 36 bar diameters for Grade 60 (420), and 24 bar diameters for Grade 40 (300). Lapped splices shall be made by securely wiring the bars in contact, maintaining alignment, and clearance.

### D. CONCRETE

#### 1. Placing Concrete

Before depositing any concrete, all dirt and other debris shall be removed from the forms. Concrete shall be handled by methods which will prevent the separation or loss of ingredients and the formation of laitance. The concrete shall be deposited in the Work as nearly as possible in its final position to avoid rehandling. The concrete shall be deposited in level layers not exceeding 12" in thickness. Suitable means shall be provided to permit concrete to be placed in a manner that will avoid accumulation of dry or hardened concrete on the forms or reinforcement. Concrete, during and immediately after depositing, shall be thoroughly consolidated by the use of vibrators specified below. The greatest care must be exercised to ensure the coating of all surfaces of the reinforcement. Equal care shall be taken to ensure that all concrete is consolidated against the face of the forms.

#### 2. Keyed Construction Joints

All keyed joints shall be of the raised type, and shall be thoroughly cleaned prior to successive concrete placements.

#### 3. Curing Concrete

Precautions shall be taken to prevent excess loss of water from the concrete. The top of the floor slab and the top of the roof shall be sealed immediately after finishing by wet burlaps, plastic, or by spraying thereon a uniform application of membrane compound conforming to "Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete" ASTM Designation C 309 for Type 2, and at approximately the rate of 1 gallon to each 150 square feet of surface. The area of the floor slab that will support the walls shall be cured with wet burlap or plastic sheeting. All exposed dowels in the floor slab shall be protected during the curing operation. When forms are removed before the concrete has reached an age of 7 days, the exposed concrete shall be cured as specified above.

#### 4. Surface Finish

The upper surface of the floor slab and the top of the roof and end walls shall be finished straight and smooth to the designated lines and slopes. They shall be finished with floats and/or steel trowels. Exposed edges shall be chamfered a minimum of 1" or as otherwise directed by the City's Project Manager. All exposed surfaces shall be finished with a Carborundum stone and water as soon as forms are removed. Upon removal of the forms, should any voids or other defects exist in the concrete surfaces, such defective concrete shall be removed at once and the space refilled with concrete and finished in a neat and workmanlike manner.

**21.06 REINFORCED CONCRETE BOX STORM DRAINS AND STRUCTURES (Continued)**

**D. CONCRETE (Continued)**

**5. Backfill for Reinforced Concrete Box Storm Drains and Structures**

Backfill along the sides of the reinforced box or structure shall not be made until tests show that the concrete has developed a compressive strength of 2000 p.s.i. Backfill over the top of the reinforced concrete box or structure shall not be made until tests show that the concrete has developed a compressive strength of 3000 p.s.i. Tests and test specimens shall comply with current ASTM standards. In the absence of tests, the following times shall elapse prior to backfilling:

| MINIMUM AVERAGE AMBIENT |             |
|-------------------------|-------------|
| <u>TEMPERATURE</u>      | <u>TIME</u> |
| 45° F                   | 17 Days     |
| 55° F                   | 8 Days      |
| 73° F                   | 5 Days      |

**E. BASIS OF PAYMENT**

When called for in the proposal, payment for reinforcing steel for reinforced concrete box storm drains and structures placed in conformance with these Standard Specifications and accepted by the City's Project Manager shall be made at the contract unit price bid per pound for REINFORCING STEEL FOR BOX STORM DRAIN, IN PLACE, or for REINFORCING STEEL FOR STRUCTURES, IN PLACE. The reinforcing steel shall not be measured separately for payment, but the quantities shall be established based upon weight of steel required for the Design Section, unless otherwise specified. Such payment shall be full compensation for all placing, tying, chairs, materials, equipment, tools, labor, and incidentals necessary to place the steel in the proper locations in conformance with the plans.

When the plans or Special Provisions provide for unit price bids per linear foot or lump sum complete for box storm drains or structures, the reinforcing steel shall not be paid for separately. The cost of the reinforcing steel shall be considered subsidiary to the costs for the items bid on the linear foot or lump sum basis as provided in Chapter 21 of these Standard Specifications.

When called for in the proposal, concrete for box storm drains or structures placed in conformance to these Standard Specifications and accepted by the City's Project Manager shall be paid for at the contract unit price bid per cubic yard for CONCRETE FOR BOX STORM DRAIN, IN PLACE, or for CONCRETE FOR STRUCTURES, IN PLACE. The concrete shall not be measured separately for payment, but the quantities shall be established based upon the volume of concrete required for the Design Section, unless otherwise specified. Such payment shall be full compensation for all mixing, hauling, forming, placing, jointing, curing, finishing, excavation, backfill, materials, equipment, tools, labor, and incidentals necessary to complete the structure.

When called for in the proposal, reinforced concrete box storm drains constructed in conformance with these Standard Specifications and accepted by the City's Project Manager shall be paid for at the contract unit price bid per linear foot for \_\_\_ X \_\_\_ REINFORCED CONCRETE BOX STORM DRAIN, COMPLETE, for the various sizes required. Such payment shall be full compensation for all excavation, bedding where required, forming, placing reinforcement, placing concrete, jointing, curing, finishing, backfill, materials, equipment, tools, labor, and incidentals necessary to construct the box and its appurtenances.



## **21.06 REINFORCED CONCRETE BOX STORM DRAINS AND STRUCTURES (Continued)**

### **E. BASIS OF PAYMENT (Continued)**

When called for in the proposal, reinforced concrete structures constructed in conformance with these Standard Specifications and accepted by the City's Project Manager shall be paid for at the contract unit price bid per lump sum for REINFORCED CONCRETE TRANSITION STRUCTURE @ STA. \_\_\_\_, COMPLETE, or REINFORCED CONCRETE STRUCTURE @ STA. \_\_\_\_, COMPLETE. Such payment shall be full compensation for all excavation, bedding where required, forming, placing reinforcement, placing concrete, jointing, curing, finishing, backfill, materials, equipment, tools, labor, and incidentals necessary to construct each structure and its appurtenances in a manner acceptable to the City's Project Manager.

## **21.07 STORM DRAIN MANHOLES**

### **A. BRICK MANHOLES**

Brick manholes shall be built where and as indicated on the plans. Their form and dimensions shall be in conformance with the drawings included with these Standard Specifications. The brick in each course shall break course with those in the adjoining courses. Mortar shall be mixed in the proportions of 1 part of Portland or mortar cement and 2 parts of sand, by volume. Every brick shall have full mortared joints on the bottom, sides and ends which shall be formed in one operation by placing sufficient mortar on the bed and forcing the brick into it. All joints shall be carefully filled and struck as the manhole is built up. The entire space between adjacent bricks shall be filled solidly with mortar. The entire inside and outside surface of the brick masonry shall be carefully plastered with mortar applied at a thickness of not less than 1/2".

Reinforced concrete manholes or precast concrete manholes shall be used, but not brick manholes, when the manhole depth is greater than 8 feet, measured from the flowline of the lowest pipe to the cast iron rim.

### **B. REINFORCED CONCRETE MANHOLES**

Reinforced concrete manholes shall be built in conformance with Chapter 21 of these Standard Specifications.

### **C. PRECAST CONCRETE MANHOLES**

Concrete manholes may also be constructed of precast sections as provided in the Lincoln Standard Plans. In the assembly of the wall rings, mortar joints, rubber gaskets, or cold-formed asphalt, joints shall be used to make the walls watertight.

### **D. BASIS OF PAYMENT**

Storm drainage manholes constructed in conformance with these Standard Specifications and accepted by the City's Project Manager shall be counted and paid for at the contract unit price bid per each for STORM DRAIN MANHOLE, \_\_\_INCHES, COMPLETE, for the various sizes required. Size of the manhole shall be identified as the largest nominal size of its intersecting storm drains. Such payment shall be full compensation for all excavation, brick, mortar, castings, precast sections, reinforcement, concrete, backfill, materials, equipment, tools, labor, and incidentals necessary to complete each manhole.

## 21.08 STORM DRAIN INLETS

### A. GENERAL

Storm drain inlets shall be constructed where and as indicated on the plans. Walls shall be made of either brick masonry or reinforced concrete. Brick masonry walls shall be built as specified above for Brick Manholes. Reinforced concrete walls shall be built as specified above for Reinforced Concrete Manholes and Chapter 21 of these Standard Specifications.

Each inlet bottom shall be fully formed so as to make the curves of the tributary drains, and all corners shall be filled with concrete as directed by the City's Project Manager.

All cast iron inlet rings, covers, grates, and the forms and dimensions of all inlets shall comply with the Lincoln Standard Plans. The ring and cover shall be adjusted to grade with brick and mortar and shall be sealed inside and out with mortar.

Reinforcing steel shall be epoxy coated and conform to the materials and construction methods of the Standard Specifications.

Each inlet shall include a length of curb and gutter as called for on the Standard Plans. Curb faces shall be transitioned gradually and uniformly to the inlet top face within 2' of the inlet top. When transitioning curb to an armored inlet top, the curb face adjacent to the inlet top should be similar to a barrier style curb with 8" vertical face.

The concrete gutter along the entire length of the inlet opening shall be constructed to form the inlet throat in accordance to the geometrics on the Inlet Throat Depression Template and per Lincoln Standard Plans.

### B. STANDARD INLET TOPS

All inlet tops shall be precast reinforced concrete in accordance with the Lincoln Standard Plans. Inlet tops shall be set to grade and sealed with mortar. The Contractor shall make all necessary adjustments to the shoulder and walls in order to set the new inlet top at the proper grade.

Inlet tops shall be placed such that a minimum of 5" inlet throat opening is established per plans, and the top of the inlet aligns with adjacent back of curb elevations. Inlet tops shall be placed in a manner that minimizes interference with snow plow operations. The faces of all inlet tops shall in no instance protrude beyond the normal gutter line or adjacent curb faces.

### C. ARMORED FACE INLET TOPS

Armored face inlet tops shall be constructed in the same manner as Standard Inlet Tops as specified above, with the addition of metal face armoring. The metal face armoring assembly shall be fabricated from steel channel and rebar and shall be galvanized per the Lincoln Standard Plans and conform to the materials and construction methods of these Standard Specifications.

## 21.08 STORM DRAIN INLETS (Continued)

### D. RECONSTRUCT INLET THROATS AND RECONSTRUCT INLET VAULTS

Inlet throats shall be reconstructed in the same manner as an inlet throat is constructed for a new inlet in accordance with the City of Lincoln Standard Plans. The concrete gutter along the entire length of the inlet opening shall be constructed to form the inlet throat in accordance to the geometrics on the Inlet Throat Depression Template and per City of Lincoln Standard Plans.

Inlet vaults shall be reconstructed in the same manner as an inlet vault is constructed for a new inlet in accordance with the City of Lincoln Standard Plans. Vault walls shall be reconstructed with either brick or reinforced concrete, based on the type of material the existing vault is constructed of.

### E. BASIS OF PAYMENT

Storm drainage inlets constructed in conformance with these Standard Specifications and accepted by the City's Project Manager shall be counted and paid for at the contract unit price bid per each for STORM DRAIN INLET, 72"; CANTED STORM DRAIN INLET, 72"; RADIUS STORM DRAIN INLET, 72"; GRATE INLET, TYPE \_\_, for the various sizes and types required. Such payment shall be full compensation for all excavation, brick, mortar, concrete, epoxy coated steel, standard inlet top, castings, curb and gutter as called for on the Standard Plans, backfill, materials, equipment, tools, labor, and incidentals necessary to complete each inlet.

Armored face storm drainage inlets constructed in conformance with these Standard Specifications and accepted by the City's Project Manager shall be counted and paid for at the contract unit price bid per each for STORM DRAIN INLET, 72" ARMORED FACE; CANTED STORM DRAIN INLET, 72" ARMORED FACE. Such payment shall be full compensation for all excavation, brick, mortar, concrete, epoxy coated steel, armored face inlet top, castings, curb and gutter as called for on the Standard Plans, backfill, materials, equipment, tools, labor, and incidentals necessary to complete each inlet.

Storm drainage inlet tops constructed in conformance with these Standard Specifications and accepted by the City's Project Manager shall be counted and paid for at the contract unit price bid per each for STORM DRAIN INLET TOP ONLY, 72"; STORM DRAIN INLET TOP ONLY, 72" ARMORED FACE. Such payment shall be full compensation for excavation, brick, mortar, concrete, epoxy coated steel, metal face armoring assembly (when called for), castings, cast iron frame and cover, labor, tools, equipment, all other materials, and all other incidentals necessary to complete placement of inlet top. Item includes the work necessary to place only the concrete inlet top on existing storm drain vaults as indicated on the Plans.

Inlet throats and vaults reconstructed in conformance with these Standard Specifications and accepted by the City's Project Manager shall be counted and paid for at the contract unit price bid per each for RECONSTRUCT INLET THROAT; RECONSTRUCT INLET VAULT. Such payment shall be full compensation for all removals, brick, mortar, concrete, epoxy coated steel, labor, tools, equipment, all other materials, and all other incidentals necessary to complete the reconstruction.

## **21.09 CONVERT INLET TO MANHOLE**

### **A. GENERAL**

When called for on the plans, existing inlets shall be converted to manholes by removing the inlet top, throat and adjacent curbs, bricking up the throat, removing and reshaping the invert if necessary, placing a new inlet top, and installing a new manhole ring and cover as directed by the City's Project Manager.

### **B. BASIS OF PAYMENT**

Inlets converted to manholes shall be paid for at the contract unit price bid per each for CONVERT INLET TO MANHOLE, COMPLETE. Such costs shall be full compensation for all excavation, backfill, curb removal, curb replacement, materials, equipment, tools, labor, and incidentals necessary to complete each conversion.

## **21.10 OPEN DITCHES**

### **A. GENERAL**

Open ditches shall be constructed in conformance with the lines and grades indicated on the plans and/or as directed by the City's Project Manager.

### **B. BASIS OF PAYMENT**

Open ditches constructed in conformance with these Standard Specifications and accepted by the City's Project Manager shall be measured using the end area method and shall be paid for at the contract unit price bid per cubic yard for CHANNEL EXCAVATION. The quantity to be used as the basis for payment shall be the quantity called for in the proposal, unless otherwise specified. Such payment shall be full compensation for all excavation, preparation of the banks for seeding when required, disposal of surplus materials, other materials, equipment, tools, labor, and incidentals necessary to complete the ditch or channel.

When indicated on the plans but not called for in the proposal, the cost of grading small ditches or reshaping ditches, as directed by the City's Project Manager, shall not be measured or paid for directly. The cost of this Work shall be considered subsidiary to the cost of the other items for which direct payment is made.

## **21.11 CONCRETE LINERS**

### **A. GENERAL**

Concrete liners for open ditches shall be built to lines, grades, and sections as shown on the plans.

### **B. BASIS OF PAYMENT**

Concrete ditch and channel liners constructed in conformance with these Standard Specifications and accepted by the City's Project Manager shall be measured and paid for at the contract unit price bid per linear foot for RC LOW FLOW LINER, \_\_\_', for the various sizes required. Such payment shall be full compensation for all excavation, forming, reinforcement, concrete, finishing, jointing, curing, sealing, backfill, materials, equipment, tools, labor, and incidentals necessary to complete the liners.

## **21.12 REINFORCED CONCRETE FLARED END SECTIONS (RC FES)**

### **A. GENERAL**

When called for on the plans, reinforced concrete flared end sections, with or without grates, shall be installed at the locations and grades indicated.

When called for on the plans, flared end sections shall be removed and salvaged to a location on the job site as directed by the City's Project Manager.

When called for on the plans, the Contractor shall remove existing flared end sections from the existing system, store the end sections on the job site, and reset the end sections at new locations as a part of the Work.

Flared end sections required to be removed and salvaged or removed and reset but damaged by the Contractor shall be replaced with new materials at the Contractor's cost.

Flared end sections to be removed and not salvaged or reset shall be disposed of by the Contractor.

### **B. BASIS OF PAYMENT**

Flared end sections to be removed or removed and reset, in conformance with these Standard Specifications and accepted by the City's Project Manager, shall be counted and paid for at the contract unit price bid per each for REMOVE RC FES, \_\_" or REMOVE AND RESET RC FES, \_\_". Such payment shall be full compensation for all excavation, backfill, bedding, jointing, materials, equipment, tools, labor and incidentals necessary to install the end sections at the locations shown on the plans, or to remove and salvage, remove and reset, or remove and dispose of the end sections.

Flared end sections and flared end sections with grates, placed in conformance with these Standard Specifications and accepted by the City's Project Manager, shall be counted and paid for at the contract unit price bid per each for RC FES, \_\_" and RC FES, w/GRATE, \_\_" ; for the various sizes called for in the proposal.

## **21.13 REMOVAL OF EXISTING STRUCTURES**

### **A. GENERAL**

When called for on the plans the Contractor shall remove appurtenant structures from the existing system. The resultant exposed ends of the system shall be either made ready to connect system extensions or plugged with permanent or temporary plugs, as indicated.

### **B. BASIS OF PAYMENT**

The removal of existing appurtenant structures as called for on the plans, completed in conformance with these Standard Specifications and accepted by the City's Project Manager, shall be counted and paid for at the contract unit price bid per each for REMOVE EXISTING MANHOLE, COMPLETE; REMOVE EXISTING INLET, COMPLETE; REMOVE EXISTING JUNCTION BOX, COMPLETE; REMOVE EXISTING GRATE INLET, COMPLETE; REMOVE EXISTING HEADWALL, COMPLETE; or REMOVE EXISTING INLET TOP ONLY. No classifications shall be made as to size of the structure or appurtenance. Such payment shall be full compensation for all excavation, removal to the line indicated, salvage of inlet tops if required, plugging, preparation of existing surfaces, backfill, materials, equipment, tools, labor, and incidentals necessary to complete the removal.

**21.14 RIP-RAP**

**A. GENERAL**

Rock rip-rap shall be placed on prepared slopes and channel bottoms at locations shown on the plans. The materials used shall be hard stone, or prepackaged material, free from earth, clay, asphalt or refuse and of such quality that it will not disintegrate from action of water or wind. Sizes of the material shall be graded as shown in Table 21.14 A.

The rock shall be angular in shape to allow interlocking between the various rock sizes.

**TABLE 21.14 A – ROCK RIP-RAP GRADATION REQUIREMENTS**

| <b>Size of Rock</b> | <b>Percent of Total Weight Smaller than the Given Size</b> | <b>Approx. Rock Size D50</b> | <b>Approx. Rock Size Dmax</b> |
|---------------------|--|------------------------------|-------------------------------|
| Type A              |  | 0.77ft                       | 1.28ft                        |
| 150 lbs             | 100  |                              |                               |
| 35 lbs              | 50   |                              |                               |
| 2 lbs               | Not to exceed 10   |                              |                               |
| Type B              |  | 1.02 ft                      | 1.61 ft                       |
| 300 lbs             | 100  |                              |                               |
| 80 lbs              | 50   |                              |                               |
| 5 lbs               | Not to exceed 10   |                              |                               |
| Type C              |  | 1.28 ft                      | 2.12 ft                       |
| 700 lbs             | 100  |                              |                               |
| 150 lbs             | 50   |                              |                               |
| 10 lbs              | Not to exceed 10   |                              |                               |

Rock Rip-Rap can be place with geotextile filter fabric or with a rock filter layer as directed by the Engineer. Geotextile conforming to the requirements of Chapter 32 of these Standard Specifications shall be placed on the prepared slopes prior to placement of the rip-rap.

Concrete or other masonry produced as a result of removal of such items at the job site may not be used as a substitute for rip-rap.

The rip-rap shall be placed at the locations and thicknesses indicated on the plans. Any appreciable variation from specified thickness shall be corrected by redistributing the rip-rap.

**B. BASIS OF PAYMENT**

Rip-rap placed in conformance with these Standard Specifications and accepted by the City’s Project Manager shall be measured by weighing the truck. Net weight shall be the basis of payment. Payment shall be made at the contract unit price bid per ton for RIP-RAP, TYPE \_\_. When using filter fabric, payment shall be made at a contract unit price bid per ton for RIP RAP, TYPE \_\_ WITH FILTER FABRIC. Placement of the geotextile filter fabric shall be considered subsidiary to the placement of the rip-rap. No measurement or payment shall be made for rip-rap produced as a result of removal of other items on the project. Such payment shall be full compensation for furnishing, preparation of slopes and subgrades, hauling, placing, excavation, backfill, materials, equipment, tools, labor, and incidentals necessary to complete the Work.

## 21.15 GABION INSTALLATION

### A. GENERAL

The Contractor shall furnish, assemble, tie, and fill gabion constructed in conformance with these Standard Specifications and placed in conformity with the lines, grades, and dimensions shown on the plans or as directed by the City's Project Manager. The location for installation of each type of gabion is indicated on the plans.

### B. CONSTRUCTION

#### 1. Assembly

Each gabion unit shall be assembled by binding together all vertical edges with wire ties on approximately 6" spacing or by a continuous piece of connecting wire stitched around the vertical edges with a coil about every 4".

#### 2. Placement

Prior to placement of gabion, the surface on which the gabion will bear shall be compacted and trimmed. Empty gabion units shall be set to line and grade as shown on the plans. Wire ties or connecting wire shall be used to join the units together. The units shall be tied together at all edges of their contact perimeters. Internal tie wires shall be uniformly spaced and securely fastened in each outside cell of the structure or where ordered by the City's Project Manager. A standard fence stretcher, chain fall, or iron rod may be used to stretch the wire baskets and hold alignment.

#### 3. Filling and Closing

The gabion shall be filled with the approved stone carefully placed by hand or machine to assure alignment and avoid bulges with a minimum of voids. Hand placing of the rock fill shall be used in the exposed faces of the gabion so that a pleasing and orderly arrangement of fill will result. The gabion shall be overfilled approximately 2" above the sides prior to closing the lids. The lid shall then be secured to the sides, ends, and diaphragms with the wire ties or connecting wire. Special attention shall be given to see that all projections or wire ends are turned into the baskets.

### C. BASIS OF PAYMENT

The Contractor shall be paid for the actual number of baskets placed and filled at the contract bid price per each for WIRE GABION, TYPE \_\_\_\_\_, IN PLACE or WIRE GABION PVC COATED, TYPE \_\_\_\_\_, IN PLACE. Such payment shall constitute full compensation for all costs of labor, equipment, tools, and materials for furnishing, assembling, filling with stone, closing, all channel excavation, backfilling, and all incidental Work necessary to complete the construction in conformance with these Standard Specifications and as shown on the Plans.

## 21.16 GEOTEXTILE FILTER FABRIC INSTALLATION

### A. GENERAL

The Work covered by these Standard Specifications shall consist of furnishing all labor, materials, and equipment necessary for installing geotextile filter fabric as shown on the plans.

### B. CONSTRUCTION

#### 1. Weep Holes

Geotextile filter fabric shall be placed at weep holes for channel liners and retaining walls as shown on the plans.

#### 2. Gabion/Embankment Stabilization

The gabion/embankment stabilization fabric shall be placed in the manner and at the locations shown on the project plans. The surface to receive the geotextiles shall be prepared to a smooth condition free of obstructions, depressions and debris. The fabric shall be placed loosely, not in a stretched condition. The gabions shall be placed so that the geotextile is not punctured. The gabions shall completely cover the fabric.

The fabric shall be placed on the slopes so as to provide a minimum overlap of 18". The geotextile shall be placed parallel to the direction of the flow and the upstream or higher panel shall overlap the downstream or lower panel. At the top of the embankment the fabric shall be keyed into the ground a minimum of 18".

The filter fabric shall be placed in the manner and at the locations shown on the project plans. The fabric shall be placed loosely, on and/or behind the gabion, not in a stretched condition. The backfill shall be placed so that the fabric is not punctured.

### C. BASIS OF PAYMENT

No additional payment shall be made for filter fabric used in constructing weephole filter pockets for R.C. Channel Liner. The filter fabric and placement shall be considered subsidiary to the cost of the R.C. Channel Liner of the various depths.

Unless shown in the schedule of quantities as a bid item, no additional payment shall be made for filter fabric placed on, behind, or under gabion. All costs of materials, labor, and equipment for furnishing and placing the filter fabric with the gabion, as shown on the plans, shall be considered subsidiary to the cost of the Gabion, In Place, of the various types.

When shown in the schedule of quantities as a bid item, geotextile filter fabric, placed in conformance with the plans and these Standard Specifications and accepted by the City's Project Manager, shall be measured and paid for at the contract unit price bid per square yard for GEOTEXTILE FILTER FABRIC, IN PLACE, with no allowance for laps or toe-in anchorage. Such payment shall be full compensation for all filter fabric, slope preparation, installing the fabric, equipment, materials, tools, labor, and incidentals necessary to complete the Work.



## 21.17 TIED CONCRETE BLOCK MAT INSTALLATION

### A. GENERAL

The Contractor shall furnish and place tied concrete block mats constructed in conformance with these Standard Specifications and placed in conformity with the lines, grades, and dimensions shown on the plans or as directed by the City's Project Manager.

### B. MATERIALS

Tied concrete block mats are manufactured from individual concrete blocks tied together with high strength polypropylene biaxial geogrid. Each block is tapered, beveled and interlocked and includes connections that prevent lateral displacement of the blocks within the mats when they are lifted for placement. Tied concrete block mats shall be Flexamat, manufactured by Motz Enterprises, Inc. or approved equal.

#### 1. Block

Furnish blocks manufactured with concrete conforming to the cement requirements of ASTM C150 and to the aggregate requirements of ASTM C33. Meet a minimum compressive strength of 5,000 psi at 28 days. Furnish blocks that have a minimum weight of 3 lb. per block and placed no further than 2 in. apart.

#### 2. Polypropylene Bi-Axial Geogrid

The geogrid will be composed of Polypropylene multifilament yarns coated with an acrylic based coating which is designed to resist degradation in environments with exposure to water and low pH (<4 pH) and high pH (>9 pH). When combined with the revetment mat this will yield a high tenacity, low elongating, and continuous filament polypropylene fibers that is securely cast into and embedded within the base of the concrete blocks and obtains connection strength greater than that of the geogrid. Ensure the geogrid meets the following requirements:

- UV Stabilization – 2% Carbon Black
- Ultimate Tensile Strength – 2055 lb/lf

#### 3. Underlayment Materials

The underlayment material shall be specified by the engineer, and shall be either Leno Weave Fabric, Curlex II or Recyclax TRM-V, or an approved equal. The backing material shall be packaged within the roll of the tied concrete block mats.

Cover the mat or otherwise protect it during long periods of storage to protect against degradation of the backing material as recommended by the manufacturer.

Mats will be rolled for shipment and are packaged with handling straps. These handling straps shall only be used for lifting below 2 ft. to place heavy duty lifting straps under rolls. Upon delivery, rolls may be left exposed for up to 30 days. If exposure will exceed 30 days, cover or tarp the rolls to minimize UV exposure.

All mats to be inspected upon delivery. Assure that all units are sound and free of defects that would interfere with the proper placing of the unit or impair the strength or permanence of the construction.

Chipping or missing concrete resulting in a weight loss exceeding 15% of the average weight of a concrete unit is grounds for rejection by the engineer. Replace, repair or patch the damaged areas per the manufacturer's recommendations.

## 21.17 TIED CONCRETE BLOCK MAT INSTALLATION (Continued)

### C. CONSTRUCTION

#### 1. Equipment

Provide the proper equipment to place the mat that will not damage the mat material or disturb the top soil subgrade and seed bed.

#### 2. Preparation

Prior to installation, prepare the subgrade as detailed in the plans. All subgrade surfaces to be smooth and free of all rocks, stones, sticks, roots, and other protrusions or debris of any kind that would result in an individual block being raised more than 3/4 in. above the adjoining blocks. When seeding is shown on the plans, provide subgrade material that can sustain growth.

Ensure the prepared subgrade provides a smooth, firm, and unyielding foundation for the mats. The subgrade shall be graded into a parabolic or trapezoidal shape to concentrate flow to middle of mat or mats.

When vegetation is required, distribute seed on the prepared topsoil subgrade before installation of the concrete mats in accordance with the specifications.

#### 3. Placement

Install mats to the line and grade shown on the plans and per the manufacturer's guidelines. The manufacturer or authorized representative will provide technical assistance during the slope preparation and installation of the concrete block mats as needed.

Provide a minimum 18 in. deep concrete mat embedment toe trench at all edges exposed to concentrated flows. Recess exterior edges subject to sheet flow a minimum of 3 in.

When needed, provide fastening or anchoring as recommended by the manufacturer or engineer for the site conditions.

For seams parallel to the flow line in ditch or channel applications, center a minimum 3 ft. wide strip of soil retention blanket under the seam. Fasten along the seam at 5 ft. maximum spacing. Parallel seams in the center of the ditch shall be avoided when possible.

Shingle seams perpendicular to the flow line with the downstream mat recessed a minimum of 2 blocks under the upstream mat and fastened together along the seam at 2 ft. maximum spacing if required by manufacturer or engineer.

### D. BASIS OF PAYMENT

Payment shall be made at the contract unit price bid per square foot for TIED CONCRETE BLOCK MAT. Such payment shall be full compensation for furnishing, preparation of slopes and subgrades, hauling, placing, excavation, backfill, materials, equipment, tools, labor, and incidentals necessary to complete the Work.

## **21.18 SUBSTANTIAL COMPLETION**

Storm drainage Work shall be considered substantially complete when all pipe is laid and backfilled; all manholes, inlets, and structures completed and backfilled; paving, sidewalks, and driveways replaced.

## **21.19 FINAL ACCEPTANCE**

The project shall be considered eligible for final acceptance by the City when all required Work is complete and accepted by the City's Project Manager, all items on plan completed, final cleanup is complete, park space finished, and correction of all deficiencies found as a result of testing and/or final inspection by the City's Project Manager.

## **21.20 GUARANTEE**

At any time during the two-year guarantee period, and within the time period allowed, the Contractor shall correct any defect in material or workmanship which has been brought to his attention. Such items shall include but not be limited to trench settlement including subsequent pavement damage, pipe leaks, and failures.